What is Claimed Is:

1. A method for decomposition of projection data acquired by scanning a set of objects using at least two x-ray spectra, the projection data including low energy projections (P_L) and high energy projections (P_H), said method comprising:

A. solving the projections P_L and P_H to determine a photoelectric line integral (A_p) component of attenuation and a Compton line integral (A_c) component of attenuation of the set of scanned objects using multi-step fitting; and

B. reconstructing a Compton image I_c and a photoelectric image I_p from A_c and A_p.

2. The method of claim 1, further including, prior to step A, performing a calibration procedure using simulated data or measured data or some combination of simulated and measured data.

3. The method of claim 1, further including, prior to step A, performing a calibration procedure, wherein said calibration procedure includes generating low energy iso-transmission contours for known values of P_L at known values of A_p and at known values of A_c.

4. The method of claim 3, wherein said calibration procedure includes, for each of said low energy iso-transmission contours, fitting A_p to a polynomial function $g_L(A_c)$, wherein g_L is a polynomial function that represents the shape of the contour.

5. The method of claim 4, wherein g_L includes a set of coefficients g_{Li} determined at said known values of P_L and said calibration procedure includes fitting the values of each coefficient g_{Li} to a polynomial function $h_{Li}(P_L)$.

6. The method of claim 1, wherein said calibration procedure includes computing minimum and maximum values of P_H for each of said low-energy iso-transmission contours as a function of P_L.

7. The method of claim 6, wherein said calibration procedure includes fitting the minimum values of P_H to a polynomial function $m_L(P_L)$.

8. The method of claim 6, wherein said calibration procedure includes fitting the maximum values of P_H to a polynomial function $n_L(P_L)$.

9. The method of claim 1, wherein said calibration procedure includes generating high energy iso-transmission contours for known values of P_H at known values of the A_p and at known values of the A_c.

10. The method of claim 9, wherein said calibration procedure includes, for each of said high energy iso-transmission contours, fitting A_p to a polynomial function $g_H(A_c)$, wherein g_H is a polynomial function that represents the shape of the contour for a given P_H.

11. The method of claim 10, wherein said g_H includes a set of coefficient g_{Hi} determined at said known values of P_H and said calibration procedure includes fitting the values of each coefficient g_{Hi} to a polynomial function $h_{Hi}(P_H)$.

12. The method of claim 1, wherein step A includes generating a low energy iso-transmission contour corresponding to P_L and a high energy iso-transmission contour corresponding to P_H.

13. The method of claim 12, wherein step A includes determining the values of the A_p and A_c at the intersection of said low energy iso-transmission contour and the high energy iso-transmission contour.

14. The method of claim 13, wherein the intersection of the low energy iso-transmission contour and the high energy iso-transmission contour is determined by equating a first polynomial function $g_L(A_c)$ representing said low energy iso-transmission contour, wherein g_L is a polynomial function that represents the shape of the contour of P_L, with a second polynomial

function $g_H(A_c)$ representing said high energy iso-transmission contour, wherein g_H is a polynomial function that represents the shape of the contour for a given P_H.

15. The method of claim 12, further including computing a modified value of the input low energy projection data (P_{Lc}) and a modified value of the input high energy projection data (P_{Hc}), wherein each of said modified values P_{Lc} and P_{Hc} are clamped to be bounded between two values.

16. The method of claim 15, including representing the low energy iso-transmission contour with a polynomial function g_L and determining a set of coefficients of g_L as a function of P_{Lc}.

17. The method of claim 15, including representing the high energy iso-transmission contour with a polynomial function g_H and determining a set of coefficients of g_H as a function of P_{Hc}.

18. The method of claim 15, further including, prior to step A, generating calibration data using P_L, wherein P_{Lc} is computed by clamping the value of P_L to lie between 0 and the maximum value of P_L used to generate said calibration data.

19. The method of claim 15, wherein the modified value P_{Hc} is determined by clamping the value of P_H to lie between a minimum value of P_H (P_{Hmin}) and a maximum value of P_H (P_{Hmax}).

20. The method of claim 19, including determining P_{Hmin} as a function of P_{Lc} and a polynomial function n_L and determining P_{Hmax} as a function of P_{Lc} and a polynomial function m_L, wherein m_L is a polynomial function that determines P_{Hmin} for a given value of P_{Lc} and wherein n_L is a polynomial function that determines P_{Hmin} for a given value of P_{Lc}.

21. The method of claim 1, wherein step A includes calculating a scaled Compton line integral value (A_{cs}) as a function of a scale factor s_c and A_c and calculating a scaled photoelectric line integral value (A_{ps}) as a function of a scale factor s_p and A_{ps}.

22. The method of claim 21, wherein step B includes constructing said I_c and said I_p as a function of said A_{cs} and said A_{ps}.

23. The method of claim 1, further including, after step B, determining an image of a basis function $X(I_X)$ and a basis function $Y(I_Y)$, by solving I_c and I_p on a pixel-by-pixel basis, wherein the basis functions $X(I_X)$ and $Y(I_Y)$ are functions linearly combined to determine the pixel intensities in I_c and I_p.

24. A method for decomposition of projection data acquired by scanning a set of objects using at least two x-ray spectra, said projection data including low energy projection data (P_L) and high energy projection data (P_H), said method comprising:

A. performing a calibration procedure using at least some simulated data or measured data or a combination of simulated and measured data, including:

i. generating low energy iso-transmission contours for known values of P_L and high energy iso-transmission contours for known values of P_H;

ii. generating a polynomial g_L that represents the shape of the low energy iso-transmission contour for each P_L, wherein g_L includes a set of coefficients g_{Li} determined at said known values of P_L;

iii. generating a polynomial g_H that represents the shape of the high energy iso-transmission contour for each P_H, wherein g_H includes a set of coefficients g_{Hi} determined at said known values of P_H;

iv. generating polynomials h_L that represents the variation of the coefficients of the polynomial g_L as a function of P_L;

v. generating polynomials h_H that represents the variation of the coefficients of the polynomial g_H as a function of P_H;

vi. determining the minimum and maximum values of P_H for each transmission line corresponding each P_L;

vii. generating a polynomial m_H that represents the variation of the minimum

value of P_H as a function of P_L; and

viii. generating a polynomial n_H that represents the variation of the maximum value of P_H as a function of P_L;

B. solving the projections P_L and P_H to determine a photoelectric line integral (A_p) component of attenuation and a Compton line integral (A_c) component of attenuation of the set of scanned objects using a multi-step fitting procedure, including:

i. computing the values of each coefficient g_{Li} using a polynomial function $h_{Li}(P_L)$ and computing the values of each coefficient g_{Hi} using a polynomial function $h_{Hi}(P_H)$; and

ii. determining A_c and A_p as a function of P_L and P_H, using the coefficients of g_L and the coefficients of g_H; and

C. reconstructing a Compton image I_c and a photoelectric image I_p from A_c and A_p.

25. The method of claim 24, further including, after step C, determining an image of a basis function $X(I_X)$ and a basis function $Y(I_Y)$, by solving image I_c and image I_p on a pixel-by-pixel basis.

26. A system for decomposing projection data for a set of scanned objects acquired using at least two x-ray spectra, said system comprising:

A. media for storing low energy projection data (P_L) and high energy projection data (P_H);

B. a decomposition module configured to determine a photoelectric line integral (A_p) component of attenuation and a Compton line integral (A_c) component of attenuation for P_L and P_H using multi-step fitting; and

C. an image construction module configured to construct a Compton image (I_c) and a photoelectric image (I_p) from the A_p and A_c.

27. The system of claim 26, wherein the decomposition module includes:

D. a calibration module configured to calibrate the decomposition module using at least some simulated data or measured data or a combination of simulated data and measured data.

28. The system of claim 27, wherein the calibration module is configured to generate low energy iso-transmission contours for known values of P_L at known values of A_p and at known values of A_c.

29. The system of claim 28, wherein the calibration module is configured, for each of said low energy iso-transmission contours, to fit A_p to a polynomial function $g_L(A_c)$, wherein g_L is a polynomial function that represents the shape of the contour.

30. The system of claim 29, wherein g_L includes a set of coefficients g_{Li} determined at said known values of P_L and the calibration module is configured to fit said set of coefficients g_{Li} to a polynomial function $h_{Li}(P_L)$.

31. The system of claim 28, wherein the calibration module is configured to compute the minimum and maximum values of P_H for each of the low-energy iso-transmission contours corresponding to P_L.

32. The system of claim 28, wherein the calibration module is configured to fit the minimum values of P_H to a polynomial function $m_L(P_L)$.

33. The system of claim 28, wherein the calibration module is configured to fit the maximum values of P_H to a polynomial function $n_L(P_L)$.

34. The system of claim 27, wherein the calibration module is configured to generate high energy iso-transmission contours for known values of P_H at known values of A_p and at known values of A_c.

35. The system of claim 34, wherein the calibration module is configured, for each of said high energy iso-transmission contours, to fit A_p to a polynomial function of $g_H(A_c)$, wherein g_H is a polynomial function that represents the shape of the contour for a given P_H.

36. The system of claim 34, wherein g_H includes a set of coefficients g_{Hi} determined at said known values of P_H and the calibration module is configured to fit said set of coefficients g_{Hi} to a polynomial function $h_{Hi}(P_H)$.

37. The system of claim 26, wherein the decomposition module is configured to generate a low energy iso-transmission contour corresponding to P_L and a high energy iso-transmission contour corresponding to P_H.

38. The system of claim 37, wherein the decomposition module is configured to determine the values of A_p and A_c at the intersection of said low energy iso-transmission contour and the high energy iso-transmission contour.

39. The method of claim 37, wherein the decomposition module is configured to compute a modified value of the input low energy projection data (P_{Lc}) and a modified value of the input high energy projection data (P_{Hc}), and configured to clamp said modified values P_{Lc} and P_{Hc} between two values.

40. The system of claim 39, wherein the decomposition module is configured to clamp the values of P_L to lie between 0 and the maximum value of P_L used to generate a set of calibration data and to compute the modified value P_{Lc} as a function of the clamped values of P_L.

41. The system of claim 39, wherein the decomposition module is configured to clamp P_{Hc} between a minimum value of P_H (P_{Hmin}) and a maximum value of P_H (P_{Hmax}).

42. The system of claim 43, wherein the decomposition module is configured to determine P_{Hmin} as a function of P_{Lc} and a polynomial n_L and to determine P_{Hmax} as a function of P_{Lc} and a polynomial m_L, wherein m_L is a polynomial function representing the coefficients of P_L for the minimum values of P_H and wherein n_L is a polynomial function representing the coefficients of P_L for the maximum values of P_H.

43. The system of claim 26, wherein the decomposition module is configured to calculate a scaled Compton line integral value (A_{cs}) as a function of a scale factor s_c and A_c and to calculate a scaled photoelectric line integral value (A_{ps}) as a function of a scale factor s_p and A_{ps}.

44. The system of claim 45, wherein the image reconstruction module is configured to reconstruct said I_c and said I_p as a function of said A_{cs} and said A_{ps}.

45. The system of claim 26, wherein the image reconstruction module is configured to determine an image of a basis function $X(I_X)$ and of a basis function $Y(I_Y)$, by solving I_c and I_p on a pixel-by-pixel basis, wherein the basis functions $X(I_X)$ and $Y(I_Y)$ are functions linearly combined to determine the pixel intensities in I_c and I_p.

46. A system for decomposing projection data for a set of scanned objects acquired using at least two x-ray spectra, said system comprising:

A. media for storing low energy projection data (P_L) and high energy projection data (P_H);

B. a calibration module configured to calibrate the decomposition module using at least some simulated data or measured data or a combination of simulated and measured data, and configured to:

i. generate a low energy iso-transmission contour corresponding to P_L and a high energy iso-transmission contour corresponding to P_H;

ii. generate a polynomial g_L that represents the shape of the low energy iso-transmission contour, wherein g_L includes a set of coefficients g_{Li}

determined at said known values of P_L;

iii. generate a polynomial g_H that represents the shape of the high energy iso-transmission contour, wherein g_H includes a set of coefficients g_{Hi} determined at said known values of P_H;

iv. generate polynomials h_L that represents the variation of the coefficients of the polynomial g_L as a function of P_L;

v. generate polynomials h_H that represents the variation of the coefficients of the polynomial g_H as a function of P_H;

vi. determine the minimum and maximum values of P_H for each transmission line corresponding each P_L;

vii. generate a polynomial m_H that represents the variation of the minimum value of P_H as a function of P_L; and

viii. generate a polynomial n_H that represents the variation of the maximum value of P_H as a function of P_L;

C. a decomposition module configured to determine a photoelectric line integral (A_p) component of attenuation and a Compton line integral (A_c) component of attenuation for P_L and P_H using multi-step fitting, and configured to:

i. compute the values of each coefficient g_{Li} using a polynomial function $h_{Li}(P_L)$ and to compute the values of each coefficient g_{Hi} using a polynomial function $h_{Hi}(P_H)$; and

ii. determine A_c and A_p as a function of P_L and P_H using the coefficients of g_L and the coefficients of g_H; and

D. an image reconstruction module configured to reconstruct a Compton image (I_c) and a photoelectric image (I_p) from the A_p and A_c.

47. The system of claim 46, wherein the image construction module is configured to determine an image of a basis function X(I_X) and of a basis function Y(I_Y), by solving image I_c and image I_p on a pixel-by-pixel basis.